CHAPTER 21
ENGINEERING CONSIDERATIONS

21-1. Introduction. This chapter provides guidance on three important engineering considerations for OE response actions: the use of engineering controls, the selection and application of geophysical instrumentation, and location surveying and mapping.

21-2. Engineering Controls. Engineering controls can be used to mitigate the effects of accidental or intentional explosions if the calculated exclusion zone for the OE items to be destroyed cannot be met. Engineering controls are used to improve personnel safety and/or to reduce the exclusion zone during removal operations. The types of engineering controls include those used for unintentional explosions and those used for intentional explosions.

a. Engineering Controls for Unintentional Detonation.

(1) An unintentional detonation occurs when the location of the detonation cannot be planned in advance. An unintentional detonation includes a detonation during excavation of a suspected OE item or a detonation in the interim holding area or collection point. An example of an engineering control commonly used for unintentional detonations is the barricade.

(2) The project team should design barricades in accordance with approved DOD standards. To implement a barricade that has previous approval by DDESB, the project team should contact USAESCH's Engineering Directorate, Structural Branch. If a barricade has not been previously approved, a complete structural design package should be submitted to USAESCH's Engineering Directorate, Structural Branch as part of the ESS. The structural design package should include design drawings, design details, calculations, drawings, and relevant testing details. The design must show how fragmentation is captured and overpressure is reduced. The design package, as part of the ESS, is forwarded to DDESB for approval.

b. Engineering Controls for Intentional Detonations. An intentional detonation is a planned, controlled detonation. Intentional detonations include blow-in-place, consolidated shots (detonation of multiple items), and open detonation/open burn areas. Engineering controls used for intentional detonations include soil cover, sandbags, and the On-Site Demolition Container.

(1) Soil Cover. If soil is proposed to be used over a to-be-detonated OE, the project team may use one of several computerized models to determine the required thickness of soil cover necessary for the intentional detonation of OE items. The Buried Explosion Module is one such computerized model. The methodology used in this software is documented in HNC-ED-CS-S-97-7-Revision 1. The use of soil as an engineering control reduces the fragment and soil ejecta distances.

(2) Sandbags. Sandbags may be used for an OE item no larger than 155-mm. If sandbags are proposed to be used as an engineering control to mitigate the fragmentation and overpressures generated during an intentional OE detonation, the project team should refer to HNC-ED-CS-S-98-7, Use of Sandbags for Mitigation of Fragmentation and Explosion effects Due to Intentional Detonation of Munitions.

(3) On-Site Ordnance Demolition Container (ODC). Another engineering control that may be proposed for the intentional detonation of OE items is the ODC. The ODC has been approved by DDESB for the intentional detonation of OE items. The ODC is designed to contain all significant explosion pressures for a total NEW of up to 6 pounds of TNT or its equivalent. The ODC is designed to capture all fragmentation from OE items with fragmentation characteristics up to those from an 81-mm mortar. When using the ODC, the required withdrawal distance is 75 feet. Detailed design drawings for the ODC and the supporting technical report, CEHNC-ED-CS-S-97-3, Safety Submission for On-Site Demolition Container for Unexploded Ordnance are available.

c. If engineering controls are required for intentional detonations, the OE Design Center should be contacted to arrange for the preparation of a design with USAESCH's Engineering Directorate, Structural Branch.

21-3. Geophysical Considerations. This section presents an overview of geophysical considerations for OE response projects. Detailed requirements for geophysical investigations during OE response projects are available from the OE MCX.

a. Types of OE Detectors. The most successful geophysical systems used as OE detectors rely on one of two technologies: magnetometry or electromagnetics. Magnetometers are limited to detecting ferrous items. Electromagnetic detectors can detect any conductive metal. Another method used for subsurface detection of munitions is ground penetrating radar. Other systems may be used as they are advanced.

b. Instrument Selection. To select the most appropriate OE detection instrument for a geophysical investigation, the following factors should be considered: site characteristics; ordnance penetration; instrument detection rates; and instrument performance during testing on a sample grid.

(1) Site Characteristics. Prior to selecting an OE detection instrument, the unique characteristics of the site should be evaluated. Features of the site which may impact an OE detection instrument include:

(a) Terrain and vegetation.

(b) Geologic conditions.

(c) Man-made features, such as utilities.

(d) Past, current and future land use.

(2) Ordnance Penetration. When planning geophysical investigations for buried UXO, it is necessary to consider possible depth of UXO. If UXO is intentionally buried, factors affecting burial depth may include type of soil, mechanical versus hand-excavation, depth of water table, etc. If the munition was fired or dropped, then the depth of penetration can be estimated by considering soil type, munition type and weight, and impact velocity. Penetration depths may be estimated using a Maximum Ordnance Penetration source document such as the nomograph found in Figure 4-8 of TM 5-855-1, Fundamentals of Design for Conventional Weapons. There are many cases where UXO can penetrate deeper than geophysical instruments can reliably detect. On such sites, it is possible that undetected UXO remains deeper than it can be detected.

(3) OE Instrument Detection Rates. Detection rates are always site-specific and are highly dependent upon the type of ordnance at the site, how the ordnance was used, how deeply it may be buried, environmental conditions, and cultural influences. Previous test results have shown that, regardless of the particular detector system tested, the best detection systems utilize computer-based post processing to assist data evaluation and target selection.

(4) OE Detection Instrument Performance.

(a) The performance of OE detection instruments varies as a result of different characteristics such as soil type, moisture content, depth to groundwater, vegetation, and type of OE. The number of environmental and OE factors affecting the performance of OE detection instruments are so numerous that a test of various potential OE detection instruments should be performed on the site to determine which instrument performs the best.

(b) The purpose of OE instrument testing is to:

- Document the consideration given to various OE detection instruments for use at a project site, the criteria used to identify geophysical instruments for consideration, and the causes for their respective selection or rejection.

- Document the capabilities and limitation of each OE detection instrument selected for consideration at the site-specific geophysical prove-out.

- Observe each OE detection instrument operating in the contractor’s configuration, using the contractor’s personnel and methodologies at the project site operating as a unit.

- Evaluate the contractor’s data collection, data transfer quality, data quality control method(s), and data transfer rates.

- Evaluate the contractor's method(s) of data analysis and evaluation.

- Evaluate estimated field production rates and estimated false positive rations, as related to project cost.

- Evaluate proposed changes to OE detection methodologies.

(c) OE detection instrumentation will be tested prior to and upon the completion of the geophysical survey of each grid to characterize system operation.

(d) A specific standardization test grid will be constructed at the project site. The location of the standardization test grid will be selected by the OE project team based upon the technical and site-specific considerations identified by the SUXOS and the project geophysicist.

(e) The standardization test grid will be seeded with inert OE items which are representative of the items expected to be recovered from the site. The number, orientation, and depths of the seeded OE items will be sufficient to characterize the limitations of the proposed OE detection equipment and to evaluate the ability of the proposed OE detection equipment to located each type of OE at the anticipated depths.

(f) Normally, the grid will be seeded by someone other than the contractor. The grid typically will contain a known portion and an unknown portion. The contractor will be provided the test grid location and the location of all seeded items on the known portion. The contractor will use the known portion of the grid to optimize the proposed methodologies. The contractor will be evaluated by the OE Design Center on the ability to characterize the unknown portion of the test grid.

(g) The results of this site-specific OE detection instrument test should be documented and included in the SOW for the removal action.

c. Geophysical Investigation Plan.

(1) The contractor must prepare a Geophysical Investigation Plan, which is a component of the project Work Plan. The purpose of the Geophysical Investigation Plan is to document the methodology for completing the geophysical investigation. The required contents for the Geophysical Investigation Plan are discussed in the OE MCX DID OE-005-05, "Geophysical Investigation Plan", which is located on the OE MCX website at http://www.hnd.usace.army.mil/oew.

d. Personnel Requirements.

(1) OE detection instrument testing will be managed by a qualified geophysicist. The requirements for the geophysicist are presented in the OE MCX DID OE-025, "Personnel/Work Standards", which is located on the OE MCX website at http://www.hnd.usace.army.mil/oew.

(2) Training and medical surveillance requirements for the on-site geophysical mapping crews will be in accordance with Chapter 24 of this document.

(3) During all field investigation activities, the crew must be accompanied by UXO personnel who will ensure that the site is safe before the team begins work. Based on-site conditions, it is possible that a UXO escort will not be required in all areas at all times after the initial site visit. However, such a decision will be made jointly by the OE Safety Specialist and UXOSO who may rescind or modify it at any time.

21-4. Location Surveying and Mapping.

a. General. This section provides an overview of location survey and mapping considerations for OE response projects. Detailed survey, mapping, and GIS requirements may be found in OE MCX DID OE-005-07, "Location Surveys and Mapping Plan", which is located on the OE MCX website at http://www.hnd.usace.army.mil/oew.

b. Location surveys and mapping will be performed by the contractor to establish primary and secondary project control; collect and compile topographic, planimetric, and/or orthometric mapping; monument and record the perimeter boundaries of an OE removal action and interior boundaries designating various depths of OE removal, if applicable; delineate the sampling areas within defined areas of concern for site characterization during an EE/CA; re-establish and mark OE-related anomalies identified during OE detection surveys and analyses; and record the geographic location of recovered OE. Project areas may be subdivided into subareas (grids) to enhance command and control within the work area.

c. Personnel. All of the location survey and mapping will be conducted and/or supervised by a professional land surveyor licensed by the appropriate Board of Registration for the applicable state. The boundary survey and metes and bounds description of each OE removal area will be stamped and sealed by the professional land surveyor in charge of the survey and mapping activities.

d. Safety Requirements. During all initial field work and all intrusive activities, the survey crew shall be accompanied by UXO personnel. The UXO personnel will conduct visual surveys for surface OE prior to the survey crew entering a suspect area. The UXO personnel will also confirm that the desired location for setting a survey reference monument, project control point, grid stake, or any other marker is free of any surface OE and subsurface anomalies. If the location is not clear of OE or potential OE, the UXO personnel will check an alternate offset location for the marker as established by the survey crew.

e. Training and Medical Surveillance. Training and medical surveillance requirements for on-site surveying crews will be in accordance with Chapter 24 of this document.

21-5. Geographic Information Systems. The GIS assembles all the data required to associate the non-intrusive subsurface geophysics investigative data to its correct geographical location, the relational database, mapping, and remote sensing data. It provides a standard methodology to assist in the assembly of all past, current, and proposed OE project information into a common reference for analysis, management and storage in a digital for the project's administrative record. GIS requirements are detailed in OE MCX DID OE-005-07, "Location Surveys and Mapping Plan", which is located on the OE MCX website at http://www.hnd.usace.army.mil/oew.